

1 **WHAT IS CLAIMED IS:**

2 ~~1.~~ A method for chemical mechanical polishing copper, barrier material and
3 dielectric material, the method which comprises the steps of:

4 a) providing a first chemical mechanical polishing slurry wherein said first
5 slurry has a high removal rate on copper and a low removal rate on said barrier material;

6 b) chemical mechanical polishing a semiconductor wafer surface with said
7 first slurry;

8 c) providing a second chemical mechanical polishing slurry wherein said
9 second slurry has a high removal rate on said barrier material, comparable removal rate
10 on copper and low removal rate on said dielectric material; and

11 d) chemical mechanical polishing said semiconductor wafer surface with said
12 second slurry.

13 2. The method of claim 1 wherein said first slurry has a copper removal rate of
14 greater than about 5000 Å/min and a barrier material removal rate of less than about 500
15 Å/min.

16 3. The method of claim 1 wherein said first slurry comprises about 1-10% colloidal
17 silica, about 1-12% potassium iodate, about 0-5% concentrated inorganic acid, and about
18 0-2% iminodiacetic acid.

19 4. The method of claim 1 wherein said first slurry comprises about 1-5% fumed
20 silica, about 1-12% potassium iodate, about 0-5% concentrated inorganic acid, and about
21 0-2% iminodiacetic acid.

22 5. The method of claim 3 wherein said colloidal silica has a particle size of about 3
23 to 100 nm.

1 6. The method of claim 4 wherein said fumed silica has a mean particle size of less
2 than about 700 nm.

3 7. The method of claim 3 wherein said first slurry further comprises potassium,
4 sodium or ammonium hydroxide in such amounts to modify the pH to a region of about 2
5 to 4.

6 8. The method of claim 4 wherein said first slurry further comprises potassium,
7 sodium or ammonium hydroxide in such amounts to modify the pH to a region of about 2
8 to 4.

9 9. The method of claim 1 wherein said second slurry has a barrier material removal
10 rate of greater than about 1000 Å/min and a copper removal rate of less than about 1000
11 Å/min and dielectric material removal rate of < 500 Å/min.

12 10. The method of claim 1 wherein said second slurry comprises about 1-10%
13 colloidal silica, about 0.1-1% potassium iodate, 0-5 % concentrated inorganic acid and
14 about 0-2% iminodiacetic acid.

15 11. The method of claim 10 wherein said colloidal silica has a particle size of less
16 than about 100 nm.

17 12. The method of claim 10 wherein said second slurry further comprises potassium,
18 sodium or ammonium hydroxide in such amounts to modify the pH to a region of about 2
19 to 5.

20 13. The method of claim 1 wherein said dielectric material is silicon oxide.

21 14. The method of claim 1 wherein said barrier material is selected from the group
22 consisting of: tungsten nitride, tantalum, tantalum nitride, silicon doped tantalum nitride,
23 titanium nitride and silicon doped titanium nitride.

1 15. The method of claim 1 wherein said first and second slurries are stable and have a
2 pH in the range of from about 2 to 5.

3 16. The method of claim 1 wherein said barrier material is tantalum.

4 17. The method of claim 1 wherein said barrier material is tantalum nitride or silicon
5 doped tantalum nitride.

6 18. The method of claim 16 wherein said first slurry has a copper removal rate of
7 greater than about 5000 Å/min and a tantalum removal rate of less than about 500 Å/min
8 and said second slurry has a tantalum removal rate of greater than about 1000 Å/min and
9 a copper removal rate of less than about 1000 Å/min and a dielectric material removal
10 rate of < 500 Å/min.

11 19. The method of claim 17 wherein said first slurry has a copper removal rate of
12 greater than about 5000 Å/min and a tantalum nitride removal rate of less than about 500
13 Å/min and said second slurry has a tantalum nitride removal rate of greater than about
14 1000 Å/min and a copper removal rate of less than about 1000 Å/min and a dielectric
15 material removal rate of < 500 Å/min.

16 20. The method of claim 1 wherein said first and second slurries comprise an
17 oxidizing agent.

18 21. The method of claim 20 wherein said oxidizing agent is an iodate salt.

19 22. The method of claim 1 wherein said first and second slurries comprise a corrosion
20 inhibitor.

21 23. The method of claim 1 wherein said first and second slurries comprise a cleaning
22 agent.

23 24. The method of claim 22 wherein said corrosion inhibitor is a carboxylic acid.

- 1 25. The method of claim 24 wherein said carboxylic acid is chosen from the group
2 consisting of: glycine, oxalic acid, malonic acid, succinic acid and nitrilotriacetic acid.
- 3 26. The method of claim 22 wherein said corrosion inhibitor is a dicarboxylic acid.
- 4 27. The method of claim 26 wherein said dicarboxylic acid has a nitrogen containing
5 functional group.
- 6 28. The method of claim 27 wherein said dicarboxylic acid is iminodiacetic acid.
- 7 29. The method of claim 23 wherein said cleaning agent is a carboxylic acid.
- 8 30. The method of claim 29 wherein said carboxylic acid is chosen from the group
9 consisting of: glycine, oxalic acid, malonic acid, succinic acid and nitrilotriacetic acid.
- 10 31. The method of claim 23 wherein said cleaning agent is a dicarboxylic acid.
- 11 32. The method of claim 31 wherein said dicarboxylic acid has a nitrogen containing
12 functional group.
- 13 33. The method of claim 32 wherein said dicarboxylic acid is iminodiacetic acid.
- 14 34. The method of claim 1 wherein said first slurry comprises colloidal silica
15 particles.
- 16 35. The method of claim 34 wherein said colloidal silica particles are about 3 to 100
17 nm in size.
- 18 36. The method of claim 34 wherein said colloidal silica particles are spherical.
- 19 37. The method of claim 35 wherein said colloidal silica particles are spherical
- 20 38. The method of claim 1 wherein said first slurry comprises fumed silica.
- 21 39. The method of claim 38 wherein said fumed silica has a mean particle size of less
22 than about 700 nm.

- 1 40. The method of claim 1 wherein said first slurry comprises colloidal silica
2 particles.
- 3 41. The method of claim 40 wherein said colloidal silica particles are about 3 to 100
4 nm in size.
- 5 42. The method of claim 40 wherein said colloidal silica particles are spherical.
- 6 43. The method of claim 41 wherein said colloidal silica particles are spherical.44.
- 7 44. The method of claim 42 wherein said particles have a narrow size distribution.
- 8 45. The method of claim 42 wherein about 99.9% of said particles are within about 3
9 sigma of a mean particle size with negligible particles larger than about 500 nm.
- 10 46. The method of claim 1 wherein said second slurry comprises colloidal silica
11 particles.
- 12 47. The method of claim 46 wherein said colloidal silica particles are about 3 to 100
13 nm in size.
- 14 48. The method of claim 46 wherein said colloidal silica particles are spherical.
- 15 49. The method of claim 47 wherein said colloidal silica particles are spherical.
- 16 50. The method of claim 1 wherein said second slurry comprises colloidal silica
17 particles.
- 18 51. The method of claim 50 wherein said colloidal silica particles are about 3 to 100
19 nm in size.
- 20 52. The method of claim 50 wherein said colloidal silica particles are spherical.
- 21 53. The method of claim 51 wherein said colloidal silica particles are spherical.
- 22 54. The method of claim 52 wherein said particles have a narrow size distribution.

1 55. The method of claim 52 wherein about 99.9% of said particles are within about 3
2 sigma of a mean particle size with negligible particles larger than about 500 nm.

3 56. The method of claim 1 wherein said first and second slurries comprise silica
4 particles, an oxidizing agent, a cleaning agent and a corrosion inhibitor.

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